Fast structural boundary condition detection using acoustic data

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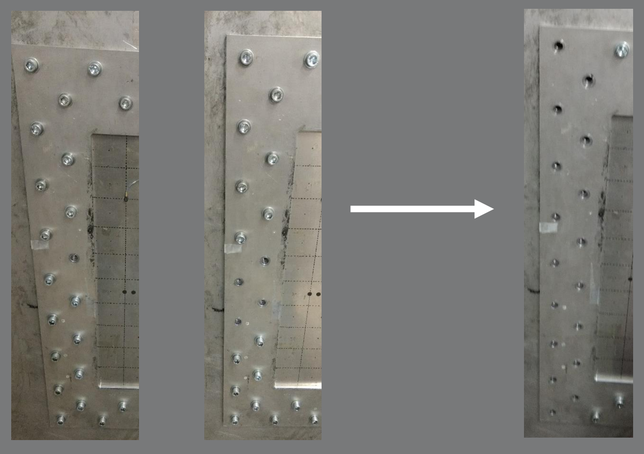
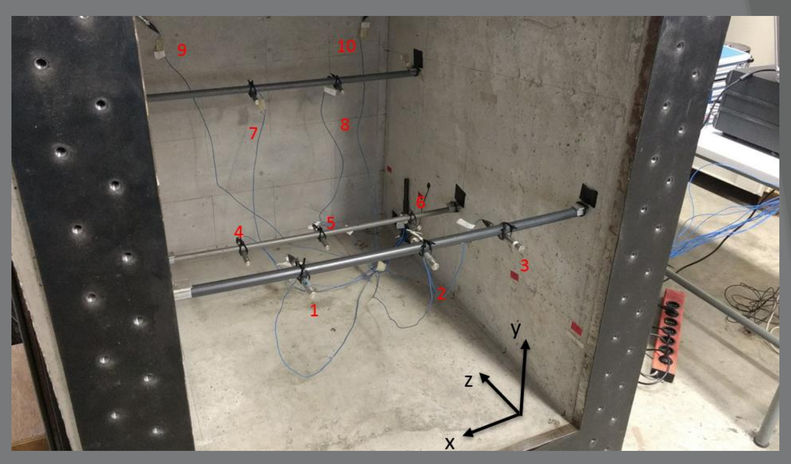
Experimental setup

Progressive removal of bolts from edge:



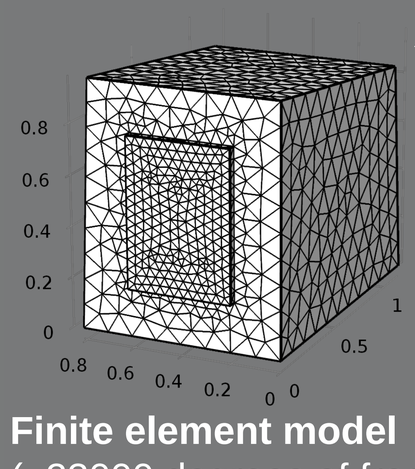
Hammer excitation:

Measure FRFs with microphones:



Model order reduction (MOR)

Project full system: $M\ddot{x}(t) + C\dot{x}(t) + Kx(t) = Bu(t)$



K, C, M, B

Finite element model
(~23000 degrees of freedom)

$$K_r = V^T K V$$

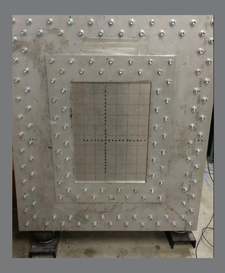
Reduced system: $M_r\ddot{\hat{x}}(t) + C_r\dot{\hat{x}}(t) + K_r\hat{x}(t) = B_r u(t)$

Keep edge parameters in reduced model (pMOR):

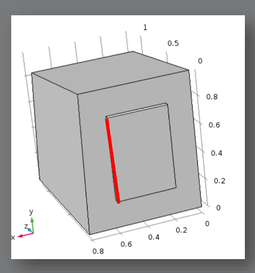
$$K(p) = K_0 + \sum_{k=1}^{\nu} p^{(k)} b_k c_k^T$$

- Low rank change stiffness matrix
- Reduced model size:
  → 200 degrees of freedom

Model updating procedure



sensors



FE model

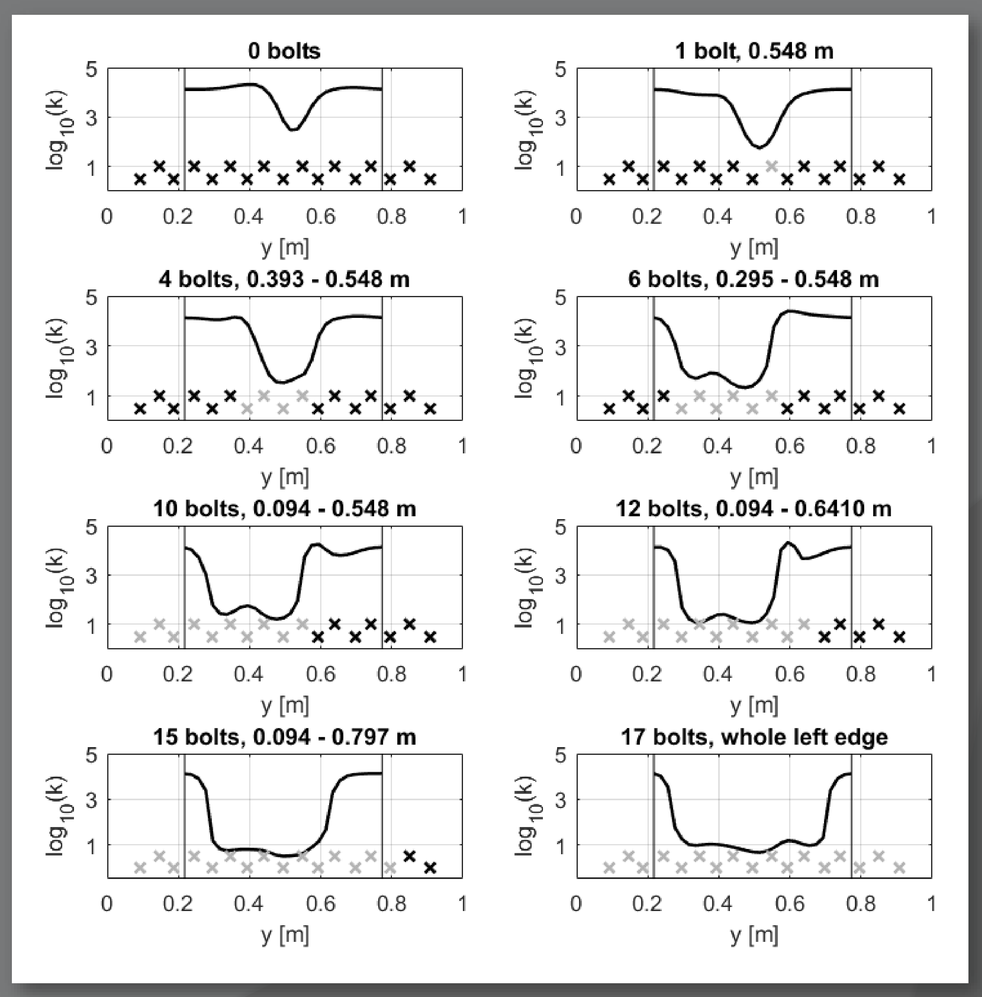
Model Updating

pMOR

Reduced model

Results

Identified loose bolts:



For more info:

S. van Ophem, A. van de Walle, E. Deckers, W. Desmet (2018*), Efficient vibro-acoustic identification of boundary conditions by low-rank parametric model order reduction*, *Mechanical Systems and Signal Processing, 111, pp 23- 35.*

Acknowledgements

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